

# Recompletion of the 1975 Mayo Warm Water Supply Well (PW1)

2010/2011 Investigation  
Yukon Territory

Prepared for  
Village of Mayo

Prepared by  
hydrogeological consultants ltd. (HCL)  
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February 2012

Project No.: 10-667.00

<p><b>PERMIT TO PRACTICE</b> HYDROGEOLOGICAL CONSULTANTS LTD.</p> <p>Signature _____ Date <u>2012-02-29</u></p> <p><b>PERMIT NUMBER P 385</b> The Association of Professional Engineers, Geologists and Geophysicists of Alberta</p>
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## 1. Introduction

The Village of Mayo (the Village) requires a warm water supply from the 1975 Mayo Warm Water Supply Well (PW1). In 2010, the Village noticed changes in the quantity and quality of groundwater from PW1 and retained Hydrogeological Consultants Ltd. (HCL) to investigate in an attempt to resolve the current issues and to help prevent further problems from occurring.

HCL prepared a proposed scope of work in January 2011 to recomplete PW1, which was approved by the Village. HCL personnel, using the services of Aqua Tech Supplies & Service Ltd. (Aqua Tech), recompleted PW1 from June to October 2011. The present report serves to document the recompletion process and the results of testing used to evaluate the recompletion.



## 2. Background

### 2.1. 1975 Mayo Warm Water Supply Well (PW1)

The Village of Mayo's PW1 was drilled and completed in 1975 with a stainless steel water well screen in the depth interval of 251.8 to 254.8 metres below ground level (BGL). PW1 free-flows groundwater to surface.

When PW1 was put into service, the warm water supply well had a specific capacity of 120 litres per minute per metre (lpm/m) of drawdown when pumping 278 lpm. In July 2002, PW1 had a specific capacity of 10.5 lpm/m of drawdown when pumping 288 lpm; this is approximately one tenth of the original specific capacity.

### 2.2. Previous Work

PW1 was serviced in the summer of 2002 in an attempt to increase the yield from the warm water supply well. Acid was used to remove any mineral or biological deposits that had accumulated on the water supply well screen. Following the servicing of PW1, the yield increased to 20.8 lpm/m of drawdown during an aquifer test conducted in November 2002. Also in 2002, a downhole video inspection of PW1 was conducted. It was observed during the video inspection that the cast-iron plug at the bottom of the water supply well screen was showing signs of corrosion.

In 2010, sand was noticed in the groundwater pumped from PW1 by the Village. A letter-report was prepared by HCL in May 2010 and was submitted to the Village detailing a proposed field work program to be completed with PW1. Following the May 2010 letter-report, Aqua Tech conducted a downhole video camera inspection of the warm water supply well. HCL reviewed the video provided by Aqua Tech and identified up to three locations where sand is infiltrating into PW1.

In January 2011, HCL submitted a scope of work to the Village to recomplete PW1.

### 3. Work Conducted

#### 3.1. Video Inspection

A video inspection of PW1 was completed prior to the recompletion of the warm water supply well to identify any features related to well construction or debris that would impact the recompletion process or design.

The top of the screen in PW1 was noted at 251.2 metres BGL, and sand was observed in the warm water supply well from 255.6 to 257.3 metres BGL.

#### 3.2. Pre-Test and Sampling

On June 30, 2011 Aquifer Test (AT) VII was conducted with PW1 by Aqua Tech under the supervision of HCL personnel. AT VII was a step-drawdown-type aquifer test. HCL also collected groundwater and sediment samples on June 30, 2011. The groundwater samples were submitted to Exova Canada Inc. (Exova) for routine and total suspended solids analyses and the sediment samples were submitted to J.R. Paine & Associates Ltd. for grain size analysis.

Aquifer test and sampling results are included in Appendix A.

#### 3.3. Recompletion and Water Well Cleaning

A 152.4-mm PVC surface casing was installed in PW1 from 0 to 166.4 metres BGL. PVC K-Packers that were 685.8-mm in length were then installed at 1.7, 5.2, 22.8, 134.1 and 165.8 metres BGL. A video inspection was then completed to ensure that the casing and packer installation was successful. The video inspection revealed sand infiltration that was thought to be caused by the surge action created during the casing and packer installation. The original field program was revised in an effort to reduce the surge action during the installation of additional well construction material for the remainder of the recompletion process.

In an effort to remove sand from the bottom of PW1, Aqua Tech telescoped a 25.4-mm steel pipe through a 50.8-mm steel pipe and landed the pipes at 152.4 metres BGL and 233.5 metres BGL, respectively. Compressed air was then injected into the 25.4-mm pipe to lift water and sand out of the warm water supply well through the 50.8-mm pipe which was landed on the top of the sand. The sand was removed to a depth of 249.9 metres BGL; the remaining 7.3 metres of sand were unable to be removed due to continuing sand infiltration.

Following the cleaning process, four water well screen sections, complete with a wash-down fitting assembly, were run into PW1 and clamped at surface. The screen assembly was then attached to 114.3-mm PVC casing. A left-hand-threaded 50.8-mm Wash-Down Running Tool was then attached to a 25.4-mm steel pipe and telescoped through the casing and screen, landing in the wash-down fitting. The screen and wash-down assembly were then lowered into the warm water supply well by adding 114.3-mm PVC casing and 25.4-mm steel pipe in unison in a manner which ensured that the weight of the screen and casing was supported by the 25.4-mm steel pipe at all times. A total of 32 joints of 114.3-mm casing were added, then a Double K-Packer Insert Receptacle was attached to the top of the casing. The total screen assembly at this point was approximately 99.3 metres in length. Additional 25.4-mm steel pipe was added in order to land the string on top of the sand at 249.9 metres BGL.

In an attempt to wash the screen assembly to total depth, a cross-over was attached to the top of the 25.4-mm steel pipe at surface, and water from the 1990 Mayo Warm Water Supply Well (PW2) was pumped into PW1 through the 25.4-mm steel pipe and the wash-down assembly. The water was pumped at 54.6 lpm for several hours; the screen assembly did not wash into the sand to total depth.

The 50.8-mm Wash-Down Running Tool and the 25.4-mm steel pipe were recovered by tightening the steel pipe. A 50.8-mm Running Sub for a Double K-Packer Latch Assembly was then attached to 50.8-mm steel pipe, which in turn was attached to a Double K-Packer Latch Assembly and telescoped through the 152.4-mm PVC surface casing. The assembly was inserted into the Double K-Packer Insert Receptacle at 150.6 metres BGL; the top of the Double K-Packer Latch Assembly was at 149.5 metres BGL. The 50.8-mm steel pipe and the Running Sub were then recovered from the warm water supply well, finishing the recompletion process.

A well diagram of PW1 is included in Appendix A.

### 3.4. Post-Test and Sampling

A 101.6-mm pump was installed in PW1 following recompletion. AT VIII with PW1 was conducted on October 13, 2011 by Aqua Tech personnel. The drawdown in PW1 during the pumping interval was more than what was expected; Aqua Tech continued to pump PW1 overnight. At the end of the pumping interval, the water level in PW1 recovered in six minutes.

On October 14, 2011 Aqua Tech conducted AT IX with PW1. AT IX was a step-drawdown-type aquifer test. Significantly less drawdown was observed during AT IX, indicating that AT VIII was successful in developing PW1. Groundwater samples were collected and submitted to Exova for routine and total suspended solids analyses. No sediment was observed in the groundwater discharge from PW1 following the recompletion.

Aquifer test and chemical analysis results are included in Appendix A.

## 4. Results

There was no significant difference between the chemical quality of the groundwater sample collected on June 30, 2011 from PW1 before recompletion, and that of the groundwater sample collected on October 14, 2011 from PW1 after the recompletion. However, as seen in the table below, the physical constituents that were analyzed were significantly lower following the recompletion. The total suspended solids concentration prior to recompletion was 378 milligrams per litre (mg/L); following recompletion, the concentration of total suspended solids was less than 1 mg/L. The Village reports that to date, no significant amounts of sediment have been observed in groundwater discharged from PW1.

	1975 Mayo Warm Water Supply Well (PW1)	
	Before Recompletion	After Recompletion
Specific Capacity (lpm/m of dd)	99	22
Total Suspended Solids (mg/L)	378	< 1
Colour (colour units)	50	< 5
Turbidity (NTU)	11.9	1.9

Based on data from AT IX conducted after the recompletion of PW1, the specific capacity of the warm water supply well is 22 lpm/metre of drawdown<sup>1</sup>. This is less than the specific capacity of PW1 prior to recompletion. The reduction in specific capacity indicates that by recompleting PW1 to prevent sand from entering the warm water supply well, the efficiency of the warm water supply well has decreased.

## 5. Conclusions

The recompletion of PW1 was successful. There are no longer significant amounts of sediment in the groundwater discharged from PW1 and, although the specific capacity has been reduced, a sufficient water supply to meet the needs of the Village remains available from the warm water supply well.

Written By:



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Junior Hydrogeologist

Reviewed By:



February 27, 2012

Jason Sanders, P.Geol.  
Project Hydrogeologist

<sup>1</sup> Specific capacity calculations for the present program assumed that the non-pumping water level (NPWL) for PW1 was 3.8 metres above top of casing (HCL, May 2010).

## 6. Bibliography

Hydrogeological Consultants Ltd. May 2010. Issues with Two Warm Water Supply Wells. 2010 Investigation. Village of Mayo. Yukon Territory. (unpublished contract report – May 2010) [10-186]

Hydrogeological Consultants Ltd. January 2011. Proposal. Recompletion of the 1975 Mayo Warm Water Supply Well (PW1). Yukon Territory.

## 7. Glossary

BGL	Below Ground Level
BTOC	Below Top of Casing
lpm	litres per minute
lpm/m of dd	litres per minute per metre of drawdown
mm	millimetres
mg/L	milligrams per litre
NPWL	non-pumping water level

**Guidelines for Canadian Drinking Water Quality – Summary Table**

<b>Constituent</b>	<b>AO</b>	<b>MAC</b>
pH (pH units)	6.5 - 8.5	---
Conductivity (µS/cm)	---	---
Total Dissolved Solids	500	---
Sodium	200	---
Potassium	---	---
Calcium	---	---
Magnesium	---	---
Total Hardness	---	---
Manganese	0.05	---
Carbonate	---	---
Bicarbonate	---	---
Total Alkalinity	---	---
Sulfate	500	---
Chloride	250	---
Fluoride	---	1.5
Iron	0.3	---
Nitrate (as N)	---	10
Nitrate	---	45
Nitrite (as N)	---	1
Nitrite	---	3.2
Nitrate + Nitrite (as N)	---	10
Total Coliforms (CFU/100 mL)	---	0*
Fecal Coliforms (CFU/100 mL)	---	0
Escherichia coli (CFU/100 mL)	---	0
Ionic Balance (%)	---	---

*Concentrations are in milligrams per litre unless otherwise stated.*

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.

**CFU/100 mL** - Colony Forming Units per 100 millilitres

**AO** - Aesthetic Objective

**MAC** - Maximum Acceptable Concentration

**SGCDWQ** - Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

\*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

## 8. Conversions

Multiply	by	To Obtain
<b><u>Length/Area</u></b>		
feet	0.304 785	metres
metres	3.281 000	feet
hectares	2.471 054	acres
centimetre	0.032 808	feet
centimetre	0.393 701	inches
acres	0.404 686	hectares
inches	25.400 000	millimetres
miles (statute)	1.609 344	kilometres
kilometres	0.621 370	miles (statute)
square feet (ft <sup>2</sup> )	0.092 903	square metres (m <sup>2</sup> )
square metres (m <sup>2</sup> )	10.763 910	square feet (ft <sup>2</sup> )
square metres (m <sup>2</sup> )	0.000 001	square kilometres (km <sup>2</sup> )
<b><u>Concentration</u></b>		
grains/gallon (UK)	14.270 050	parts per million (ppm)
parts per million (ppm)	0.998 859	milligrams per litre (mg/L)
milligrams per litre (mg/L)	1.001 142	parts per million (ppm)
<b><u>Volume (capacity)</u></b>		
acre feet	1233.481 838	cubic metres
cubic feet	0.028 317	cubic metres
cubic metres	35.314 667	cubic feet
cubic metres	219.969 248	imperial gallons (UK)
cubic metres	264.172 050	gallons (US liquid)
cubic metres	1000.000 000	litres
cubic metres	6.290 000	Barrels of Oil Equivalent (BOE)
imperial gallons (UK)	0.004 546	cubic metres
imperial gallons (UK)	4.546 000	litres
<b><u>Rate</u></b>		
litres per minute	0.219 974	imperial gallons per minute (ipgm)
litres per minute	1.440 000	cubic metres/day (m <sup>3</sup> /day)
imperial gallons per minute (ipgm)	6.546 300	cubic metres/day (m <sup>3</sup> /day)
cubic metres/day (m <sup>3</sup> /day)	0.152 759	imperial gallons per minute (ipgm)
<b><u>Pressure</u></b>		
pound per square inch (psi)	6.894 757	kilopascal (kpa)
kilopascal (kpa)	0.145 038	pound per square inch (psi)
<b><u>Miscellaneous</u></b>		
Celsius	$F^{\circ} = 9/5 (C^{\circ} + 32)$	Fahrenheit
Fahrenheit	$C^{\circ} = (F^{\circ} - 32) * 5/9$	Celsius
degrees	0.017 453	radians

## 1975 Mayo Warm Water Supply Well (PW1)

(Mayo Water Test Hole No. 3-75)

**SE 13-123-03 W5M**

(M40261.518547)

### Well Spatial Location:

Easting: **-1,022,344**

Northing: **7,218,787**

::(spatial accuracy MT GPS — 10TM NAD83)

Ground Elevation AMSL (m): **517**

::(elevation accuracy MT DEM)

Date Completed: **Not Available**

Depth Drilled (m): **268.8**

Completion Interval (m): **254.2 — 257.2 \***

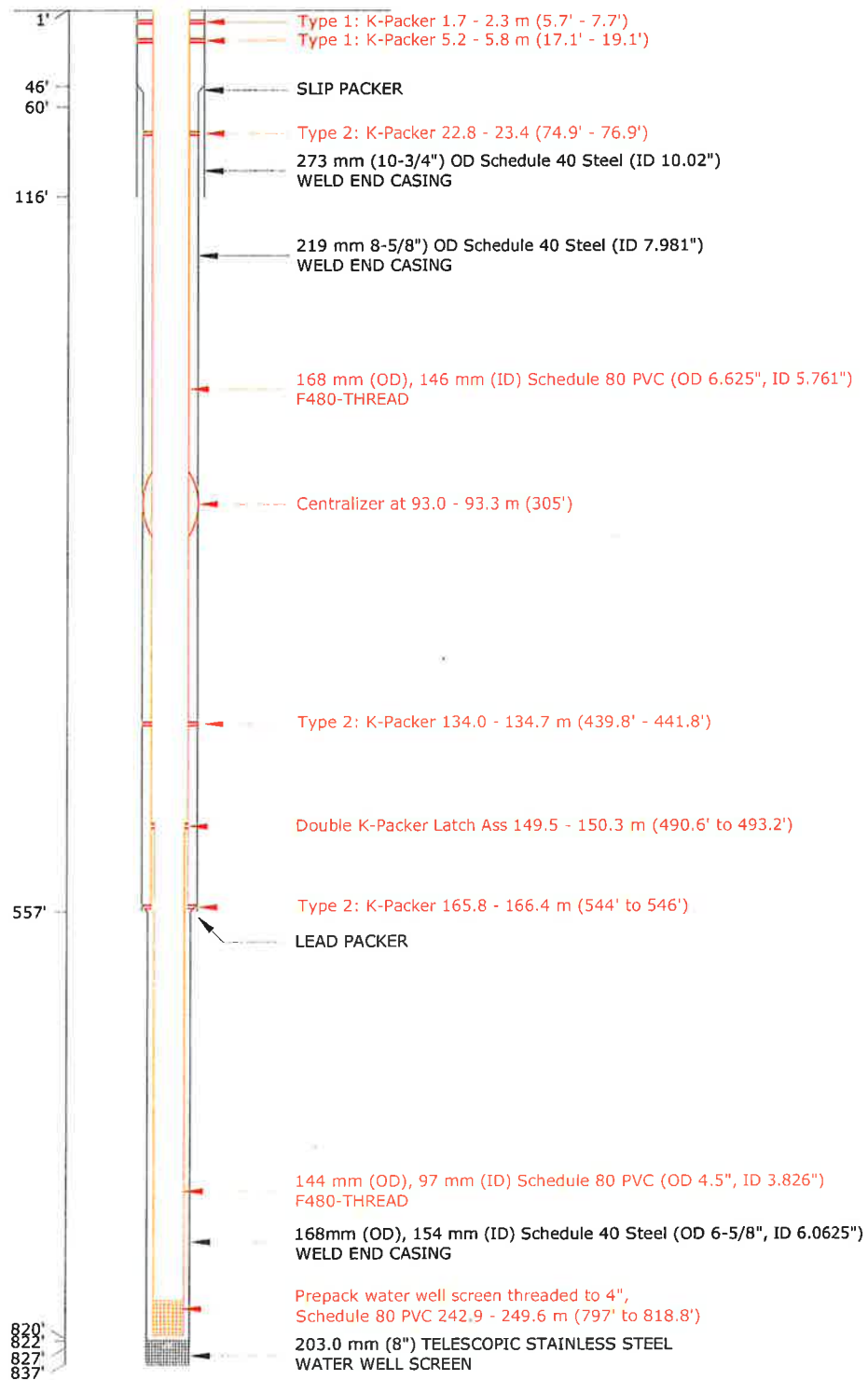
::(\* TGWC determined value)

Most Recent Water Level (m): **0.00 — October 14, 2011**

Earliest Water Level (m): **0.00 — June 30, 2011**



### 1975 Mayo Warm Water Supply Well (PW1) Well Diagram



**Note:**

Type 1: 152.4 mm (6") Schedule 80 PVC x 259.1 mm (10.202")  
 Type 2: 152.4 mm (6") Schedule 80 PVC x 202.7 mm (7.981")



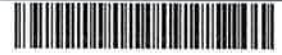
Owner: *Village of Mayo*  
 P.O. Box 160, Mayo, YT Y0B 1M0  
 Contractor: *Midnight Sun Drilling Ltd.*  
 Well Name: *1975 Mayo Warm Water Supply Well (PW1)*  
 Field Survey: *March 24, 2010 - Confirmed - Expected Location*

**METRIC REPORT**

SE 13-123-03 W5M

Easting (m): -1022343.53\*\* 75/80  
 Northing (m): 7218787.42\*\*  
 Elevation (m): 517\*\*\*  
[Google Earth](#)

M40261.518547



191997-9

Work Type: *New Well*  
 Drilling Method: *Drilled*  
 Proposed Use: *Municipal*  
 Completion Type: *Screen*  
 Well Status: *Producing*

Elog Taken: *No*  
 Gamma Taken: *No*  
 Flowing Yes

**General Details**  
 Depth Completed (m): *268.8* Top of Bedrock: *Surficial Water Well \**  
 Depth Drilled (m): *268.8* Completion Interval (m): *254.2 — 257.2 \**

**Lithology Details**

Elevation (AMSL)	Depth (BGL)	Lithology Descriptions (rate lpm)
511.2	5.8	Sand & Gravel
509.7	7.3	Sand & Gravel
507.6	9.4	Sand
490.2	26.8	Sandy Clay & Silt
386.8	130.2	Sandy Clay & Silt
265.2	251.8	Till
264.0	253.0	Sand
262.2	254.8	Gravel
250.0	267.0	Till
248.2	268.8	Bedrock

Sand & Gravel Thickness (m): *3.0 (below 15 m) \**  
 Plugged / Backfilled (m): *255.1 — 268.8 (Cuttings)*

**Completion Details**  
 Surface Casing: *Steel — 219.1 mm (O.D.) x 254.19 m (bottom)*  
 Liner: *Steel — 168.3 mm (O.D.)*  
 Screen Material: *Steel — (Washdown)*

Pack: *Natural*  
 Intervals (Liner: 163.4 m - 255.1 m)

Completion Interval: *Screen: 254.2 to 257.2 m*  
 Construction Interval: *Casing: 0.0 to 166.4 m*  
 Construction Interval: *K-Packer: 1.7 to 2.3 m*  
 Construction Interval: *K-Packer: 5.2 to 5.8 m*  
 Construction Interval: *K-Packer: 22.8 to 23.4 m*  
 Construction Interval: *Centralizer: 93.0 to 93.3 m*  
 Construction Interval: *K-Packer: 134.0 to 134.7 m*  
 Construction Interval: *K-Packer: 149.5 to 150.3 m*

**Chemistry Summary Details (mg/L, except as noted) (most recent first)**

Sampling Details: *October 14, 2011 @ 11:15*  
 Analysis Details: *October 26, 2011 - Exova (833698-1)*

Constituent	Result	Constituent	Result	Constituent	Result
Conductivity (µS/cm):	588	Nitrate as N:	< 0.01	Colour (TCU):	< 5
TDS (Calculated):	344	Nitrite as N:	< 0.005	Turbidity (NTU):	1.9
Hardness (as CaCO3):	199	pH (pH Unit):	8.25	Fluoride:	0.18
T-Alkalinity (as CaCO3):	238	Ion Balance (%):	104	Carbonate:	< 6
P-Alkalinity (as CaCO3):	< 5	Total Coliforms**:		Bicarbonate:	290
Nitrate + Nitrite as N:	< 0.01	Fecal Coliforms**:		Hydroxide:	< 5
Total Suspended Solids:	< 1	Escherichia coli**:		Total Iron:	
Sulfate Reducing Bacteria*:				Total Mn:	
Iron Related Bacteria*:				Temperature (°C):	17.3

Constituent	Extractable	Dissolved	Constituent	Extractable	Dissolved
Calcium:	43.8		Mercury:		
Chloride:		1.5	Molybdenum:		
Iron:	0.21		Magnesium:	21.6	
Manganese:	0.050		Sodium:	58.4	
Aluminum:			Potassium:	1.6	
Arsenic:			Vanadium:		
Barium:			Strontium:		
Beryllium:			Nickel:		
Cadmium:			Zinc:		
Chromium:			Copper:		
Cobalt:			Lead:		
Sulfate:	73.7				

Comments: *Sample collected by Aqua Tech Supplies & Services.*

**General Comments / Observations**

*Stanley Associates Engineering Ltd. reported the water well is located within a Public Works compound in the northwestern part of the village of Mayo (September 13, 1990).*

Most Recent Water Level (m): *0.00 m — October 14, 2011*

Oil Present: *No*  
 Gas Present: *No*

Water Used For Drilling

*note: constituents have been compared to the maximum acceptable concentration, Health Canada 2010. Guidelines for Canadian Drinking Water Quality - Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

**Aquifer Tests**

No.	Date	Testing Method	Duration (minutes)		Avg. Rate (lpm)	NPWL (metre)	Drawdown (metre)	Level-End (metre)	Pump (metre)	Q20 (m³/day)*		Transmissivity (m²/day)*	
			Pumping	Recovery						Apparent	Effective	Apparent	Aquifer Effective
9	2011-10-14 08:50	Pump	159.0	2.0	step test		34.88	34.88	98.50	1862.2	19.3		R C
8	2011-10-13 15:59	Pump	976.0	6.0	170.6		74.98	74.98	98.50	387.7	4.0		R C
7	2011-06-30 10:35	Pump	60.0		step test		6.15	6.15	30.50		179.3		R C
6	2002-11-13	Pump	240.0		step test	—	63.61	63.61	—	1274.8	13.4		R C

Alias IDs

\* The Groundwater Centre (TGWC) calculated or determined value.  
 \*\* 75 - MT GPS — 10TM NAD83  
 \*\*\* 80 - MT DEM — (Ground; AMSL)

This report was generated on: January 20, 2012 — Data "AS IS"; no warranty either expressed or implied. [63.595578 -135.905829 (WGS 84)], INT



**1975 Mayo Warm Water Supply Well (PW1)  
 Chemical Analysis (June 30, 2011)**

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**Analytical Report**

Bill To: Hydrogeological Consultants	Project:	Lot ID: <b>813818</b>
Report To: Hydrogeological Consultants	ID: 10-667	Control Number: Z-767664
17740 - 118 Avenue	Name: Recompletion of the 1975 Mayo	Date Received: Jul 11, 2011
Edmonton, AB, Canada	Location: Yukon Territory	Date Reported: Jul 14, 2011
T5S 2W3	LSD:	Report Number: 1451850
Attn: Tara Parker	P.O.: 14769	
Sampled By: Mike Semple	Acct code:	
Company:		

Reference Number 813818-1  
 Sample Date June 30, 2011  
 Sample Time 11:30  
 Sample Location  
 Sample Description M40261.518547 (Mayo PW1)  
 Sample Matrix Water

Analyte	Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments	
<b>Physical and Aggregate Properties</b>						
Colour	Apparent, Potable	Colour units	50	5	15	Above AO
Turbidity		NTU	11.9	0.1	0.1	Above OG
Solids	Total Suspended	mg/L	378	2		
<b>Routine Water</b>						
pH			8.21		6.5 - 8.5	Within AO
Temperature of observed pH		°C	22.0			
Electrical Conductivity		µS/cm at 25 C	572	1		
Calcium	Extractable	mg/L	45.6	0.2		
Magnesium	Extractable	mg/L	20.8	0.2		
Sodium	Extractable	mg/L	62.4	0.4	200	Below AO
Potassium	Extractable	mg/L	1.9	0.4		
Iron	Extractable	mg/L	1.62	0.01	0.3	Above AO
Manganese	Extractable	mg/L	0.076	0.005	0.05	Above AO
Chloride	Dissolved	mg/L	1.8	0.4	250	Below AO
Fluoride		mg/L	0.17	0.05	1.5	Below MAC
Nitrate - N		mg/L	0.03	0.01	10	Below MAC
Nitrite - N		mg/L	<0.005	0.005	1	Below MAC
Nitrate and Nitrite - N		mg/L	0.03	0.01	10	Below MAC
Sulfate (SO4)		mg/L	73.2	0.9	500	Below AO
Hydroxide		mg/L	<5	5		
Carbonate		mg/L	<6	6		
Bicarbonate		mg/L	318	5		
P-Alkalinity	as CaCO3	mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	260	5		
Total Dissolved Solids		mg/L	362	1	500	Below AO
Hardness	as CaCO3	mg/L	199			
Ionic Balance		%	100			

Terms and Conditions: [www.exova.ca/terms&conditions](http://www.exova.ca/terms&conditions)



**1975 Mayo Warm Water Supply Well (PW1)  
 Chemical Analysis (October 14, 2011)**

Exova  
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**Analytical Report**

Bill To: Hydrogeological Consultants	Project:	Lot ID: <b>833698</b>
Report To: Hydrogeological Consultants	ID: 10-667	Control Number: Z-630881
17740 - 118 Avenue	Name: Recompletion of the 1975 Mayo	Date Received: Oct 21, 2011
Edmonton, AB, Canada	Location: Yukon Territory	Date Reported: Oct 26, 2011
T5S 2W3	LSD: Village of Mayo	Report Number: 1490670
Attn: Tara Parker	P.O.: 14983	
Sampled By:	Acct code:	
Company: Aqua Tech Supplies & Services		

Reference Number	833698-1
Sample Date	October 14, 2011
Sample Time	11:15
Sample Location	
Sample Description	M40261.518547 (Mayo PW1) / 11.8°C
Sample Matrix	Water

Analyte	Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments	
<b>Physical and Aggregate Properties</b>						
Colour	Apparent, Potable	Colour units	<5	5	15	Below AO
Turbidity		NTU	1.9	0.1	0.1	Above OG
Solids	Total Suspended	mg/L	<1	2		
<b>Routine Water</b>						
pH			8.25		6.5 - 8.5	Within AO
Temperature of observed pH		°C	17.3			
Electrical Conductivity		µS/cm at 25 C	588	1		
Calcium	Extractable	mg/L	43.8	0.2		
Magnesium	Extractable	mg/L	21.6	0.2		
Sodium	Extractable	mg/L	58.4	0.4	200	Below AO
Potassium	Extractable	mg/L	1.6	0.4		
Iron	Extractable	mg/L	0.21	0.01	0.3	Below AO
Manganese	Extractable	mg/L	0.050	0.005	0.05	Below AO
Chloride	Dissolved	mg/L	1.5	0.4	250	Below AO
Fluoride		mg/L	0.18	0.05	1.5	Below MAC
Nitrate - N		mg/L	<0.01	0.01	10	Below MAC
Nitrite - N		mg/L	<0.005	0.005	1	Below MAC
Nitrate and Nitrite - N		mg/L	<0.01	0.01	10	Below MAC
Sulfate (SO4)		mg/L	73.7	0.9	500	Below AO
Hydroxide		mg/L	<5	5		
Carbonate		mg/L	<6	6		
Bicarbonate		mg/L	290	5		
P-Alkalinity	as CaCO3	mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	238	5		
Total Dissolved Solids		mg/L	344	1	500	Below AO
Hardness	as CaCO3	mg/L	199			
Ionic Balance		%	104			

Approved by: *Anthony Neumann*  
 Anthony Neumann, MSc  
 Laboratory Operations Manager

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**1975 Mayo Warm Water Supply Well (PW1)**  
**Grain Size Analysis**

From: J R Paine & Associates LTD

To: 7804849413

07/15/2011 12:17

#808 P.002/002



**J.R. Paine & Associates Ltd.**

CONSULTING AND TESTING ENGINEERS  
 EDMONTON - GRANDE PRAIRIE - PEACE RIVER

SCREEN ANALYSIS

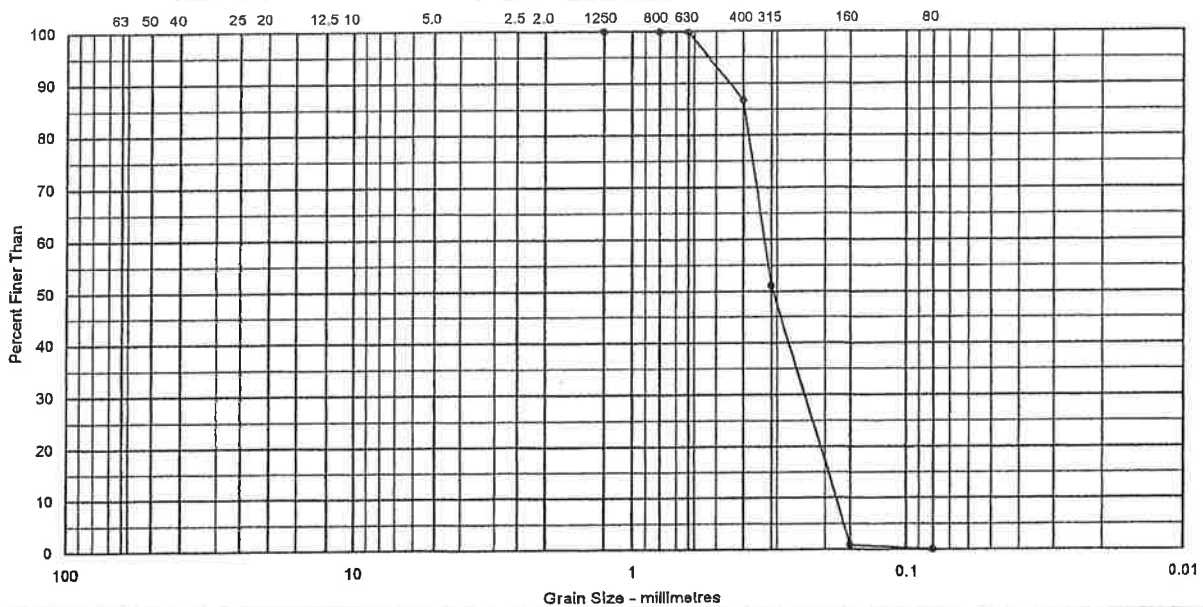
Client: Hydrogeological Consultants Ltd.  
 Sample: WW No. 1 Depth: \_\_\_\_\_  
 Location: Sand Vac From Well Bottom Project: 10-667 - Mayo Well Sample  
 Date Sampled: July 6, 2011 Made By: JW/MW File: Edmonton General  
 Ck'd By: \_\_\_\_\_ Date: July 13, 2011

Sieve No.	Size of Opening millimetres	Specifications		Percent Finer Than	Percent Finer Than Basis Original Sample
		Minimum	Maximum		
50,000	50.0				
40,000	40.0				
25,000	25.0				
20,000	20.0				
12,500	12.5				
10,000	10.0				
5,000	5.0				
2,500	2.5				
2,000	2.0				
1,250	1.25				100.0
800	0.800				99.9
630	0.630				99.8
400	0.400				86.7
315	0.315				51.0
160	0.160				0.9
80	0.080				0.0

Description of Sample: \_\_\_\_\_  
Sand  
 \_\_\_\_\_  
 \_\_\_\_\_

Method of Preparation: Dry  Washed   
 Moisture Content: \_\_\_\_\_ % 2 Face Crush Count = \_\_\_\_\_ %  
 Remarks: Sampled by Client.

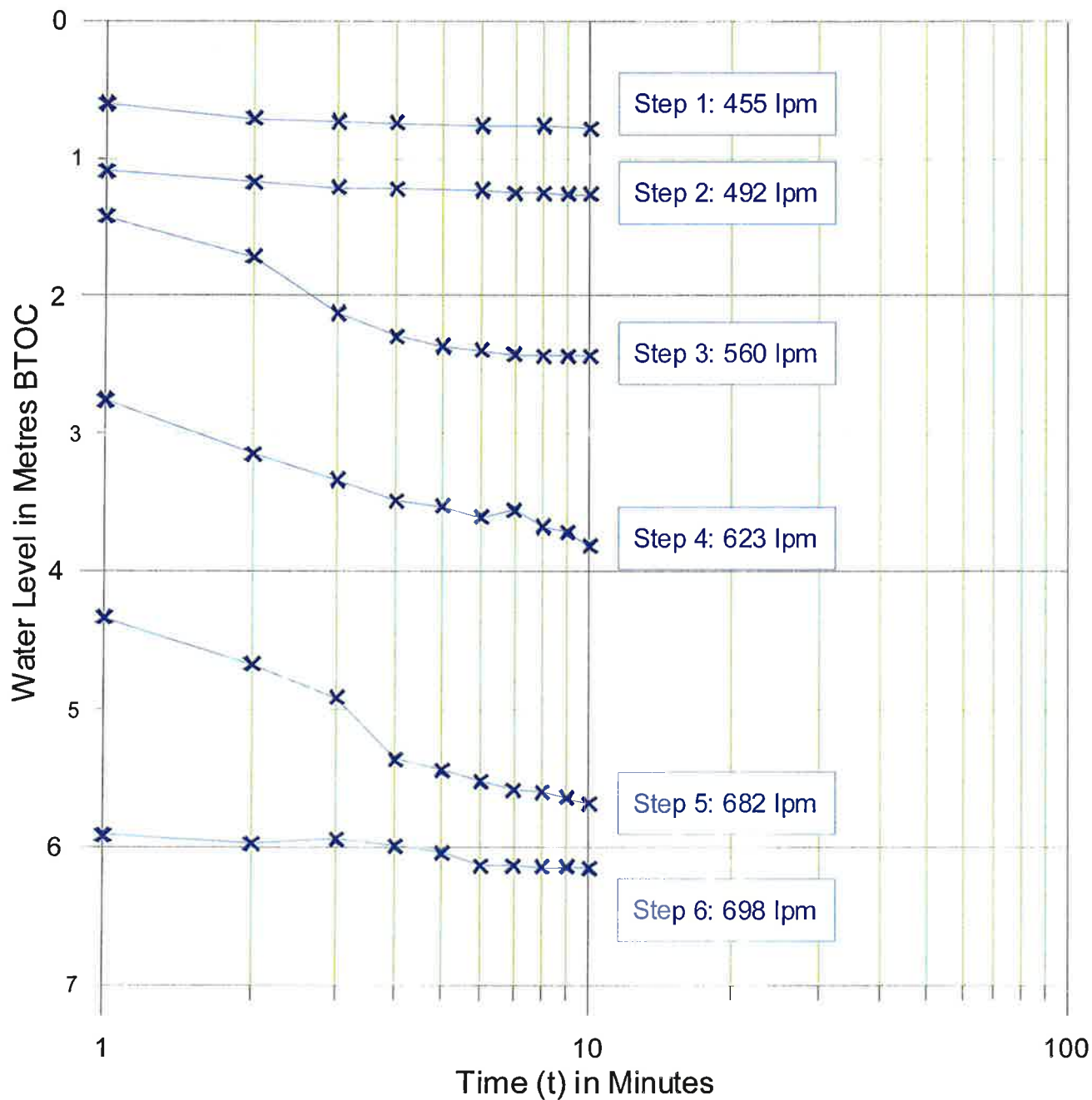
Time of Sieving: 15 minutes



Received Time Jul. 15. 2011 1:09PM No. 6266



**1975 Mayo Warm Water Supply Well (PW1)  
Aquifer Test VII**



## Aquifer Test VII

### 1975 Mayo Warm Water Supply Well (PW1) SE 13-123-03 W5M

#### Step Drawdown Manual Measurements

<u>Test Details</u>		<u>Well Details</u>		
Discharge (lpm)	Variable	Pre-test Water Level (m)	Flowing	
Date Test Started	June 30, 2011	Depth to Pump Intake (m)	30.5	
Time Test Started (Hrs)	10:35	Top of Aquifer (m)	N/A	
Pumping Interval (min)	60	Completion Interval Top (m)	254.2	
Recovery Interval (min)	0	Completion Interval Bottom (m)	257.2	

Reference Point: Top of Casing  
 Reference: M40261.518547 (AT 7)

#### Pumping Interval

	<u>Time (t) Since Pumping Started (minutes)</u>	<u>Depth to Water (metres)</u>		<u>Time (t) Since Pumping Started (minutes)</u>	<u>Depth to Water (metres)</u>
Step 1: 455 lpm	1	0.60	Step 4: 623 lpm	1	2.75
	2	0.71		2	3.14
	3	0.73		3	3.33
	4	0.74		4	3.48
	6	0.76		5	3.52
	8	0.76		6	3.60
	10	0.78		7	3.55
				8	3.67
				9	3.71
				10	3.81
Step 2: 492 lpm	1	1.09	Step 5: 682 lpm	1	4.33
	2	1.17		2	4.67
	3	1.21		3	4.91
	4	1.22		4	5.36
	6	1.23		5	5.44
	7	1.25		6	5.52
	8	1.25		7	5.58
	9	1.26		8	5.60
	10	1.26		9	5.64
				10	5.68
Step 3: 560 lpm	1	1.42	Step 5: 698 lpm	1	5.91
	2	1.71		2	5.97
	3	2.12		3	5.94
	4	2.29		4	5.99
	5	2.36		5	6.04
	6	2.39		6	6.13
	7	2.42		7	6.13
	8	2.43		8	6.14
	9	2.43		9	6.14
	10	2.43		10	6.15

**Comments:**

Aquifer test conducted by Aqua Tech Supplies & Services Ltd. under the direction of HCL. Water well flowing at 446 lpm. Flow rate determined by pumping water from the water well until water level was at the top of casing



**Aquifer Test VIII**  
**1975 Mayo Warm Water Supply Well (PW1)**  
 (formerly Mayo Water Test Hole No. 3-75)

**SE 13-123-03 W5M**

Average Discharge (lpm): <b>170.6</b>	Pre-Test Water Level - NPWL (m): <b>Flowing</b>
Date Test Started: <b>October 13, 2011</b>	Depth to Pump Intake (m): <b>98.5</b>
Time Test Started (hours): <b>15:59</b>	Test Interval - Top (m): <b>254.2</b>
Pumping Interval (minutes): <b>976</b>	Test Interval - Bottom (m): <b>257.2</b>
Recovery Interval (minutes): <b>6</b>	Top of Main Aquifer (m):* <b>N/A</b>

*N/A - Information Not Available*

*Reference: M40261.518547 (AT 8)*

*\* TGWC calculated or determined value.*

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**Pumping Interval**

Measurement Point: Top of Casing

Time (t) Since Pumping Started (minutes)	Depth to Water (metre)	Discharge (Lpm)
3	68.67	295.0
4	74.93	238.0
5	77.26	215.0
6	77.15	189.0
7	77.50	189.0
8	77.48	191.0
9	77.79	180.0
10	77.87	176.0
11	77.82	176.0
12	77.54	192.0
13	77.36	188.0
14	77.40	176.0
15	76.23	188.0
16	76.15	192.0
17	76.37	181.0
18	76.50	174.0
19	76.19	168.0
20	75.42	185.0
21	75.15	185.0
22	75.47	179.0
23	75.63	172.0
24	75.66	166.0
25	75.77	132.0
26	75.72	163.0
27	77.50	160.0
28	75.81	156.0
29	75.94	158.0
30	75.94	156.0
31	75.84	158.0
32	75.82	158.0
33	75.57	170.0
34	75.43	178.0
35	75.37	177.0
36	75.37	177.0
37	75.54	170.0
38	75.57	166.0
39	75.60	166.0
40	75.45	166.0
41	75.40	163.0
42	75.00	176.0
43	74.97	176.0
44	74.98	176.0
45	75.10	166.0
46	75.09	165.0
47	75.16	166.0
48	75.05	173.0
49	74.99	171.0
50	74.97	175.0
51	75.02	170.0

**Recovery Interval**

Measurement Point: Top of Casing

Time (t') Since Pumping Stopped (minutes)	(t'/t')	Residual Drawdown (s) (metre)
1	977	59.48
2	489	46.43
3	326	32.41
4	245	21.00
5	196	9.68
6	164	0.00



**Aquifer Test VIII**  
**1975 Mayo Warm Water Supply Well (PW1)**  
(formerly Mayo Water Test Hole No. 3-75)

**SE 13-123-03 W5M**

Average Discharge (lpm):	<b>170.6</b>	Pre-Test Water Level - NPWL (m):	<b>Flowing</b>
Date Test Started:	<b>October 13, 2011</b>	Depth to Pump Intake (m):	<b>98.5</b>
Time Test Started (hours):	<b>15:59</b>	Test Interval - Top (m):	<b>254.2</b>
Pumping Interval (minutes):	<b>976</b>	Test Interval - Bottom (m):	<b>257.2</b>
Recovery Interval (minutes):	<b>6</b>	Top of Main Aquifer (m):*	<b>N/A</b>

*N/A - Information Not Available*

*Reference: M40261.518547 (AT 8)*

*\* TGWC calculated or determined value.*

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52	75.01	170.0
53	75.03	169.0
54	75.06	164.0
55	75.08	165.0
56	75.03	169.0
57	74.90	174.0
58	74.89	173.0
59	74.97	170.0
60	74.97	169.0
61	74.95	170.0
91	74.96	169.0
151	74.93	170.0
211	74.67	168.0
361	75.08	171.0
826	75.02	170.0
961	74.97	170.0
976	74.98	170.0

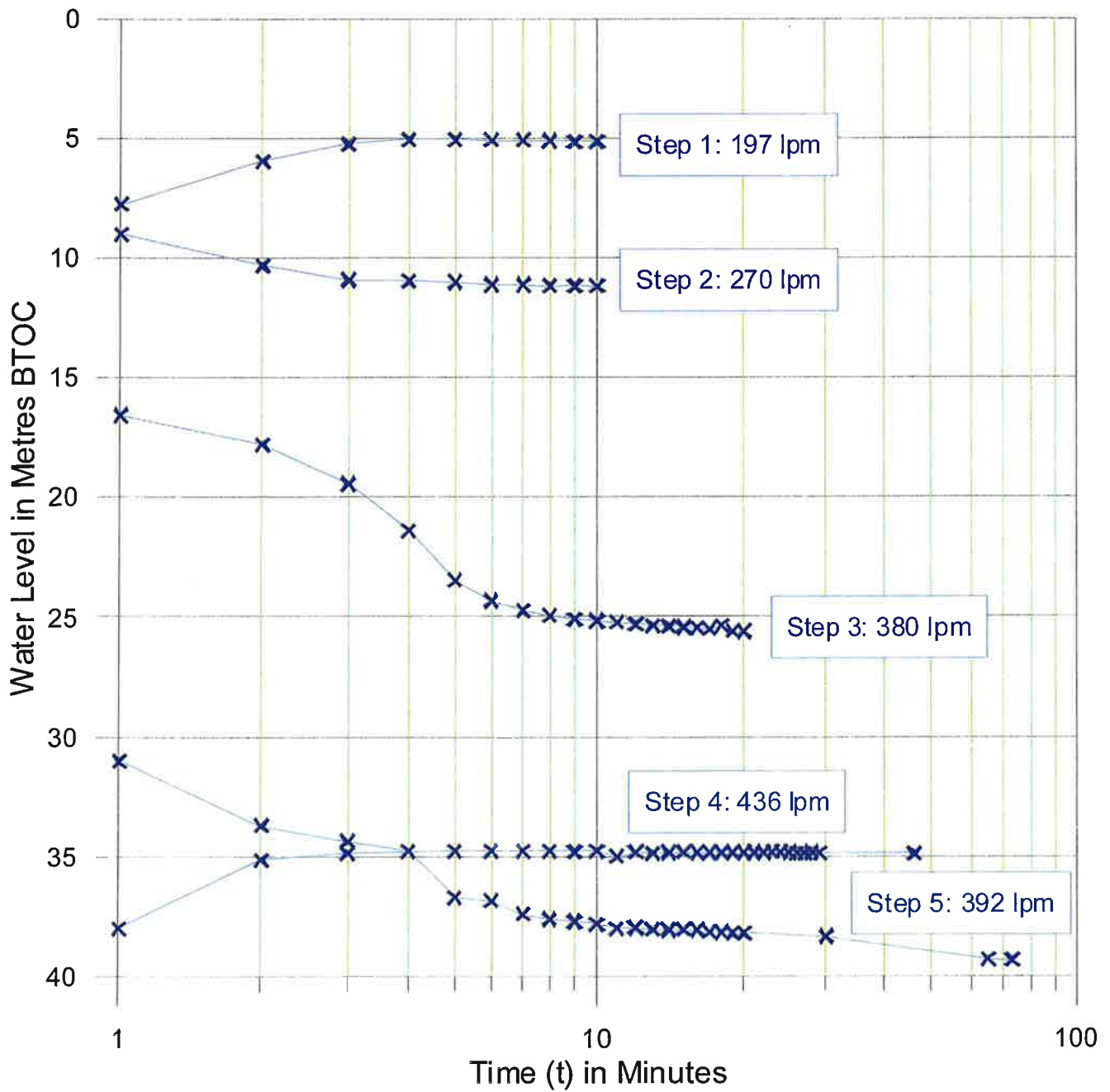
Test Comments:

Aquifer test conducted by Aqua Tech Supplies & Services Ltd.

Water well was flowing at 38 l/min prior to aquifer test start.



### 1975 Mayo Warm Water Supply Well (PW1) Aquifer Test IX



**Aquifer Test IX**  
 1975 Mayo Warm Water Supply Well (PW1)  
 SE 13-123-03 W5M

**Step Drawdown  
 Manual Measurements**

<u>Test Details</u>		<u>Well Details</u>	
Discharge (lpm)	Variable	Pre-test Water Level (m)	Flowing
Date Test Started	October 14, 2011	Depth to Pump Intake (m)	98.5
Time Test Started (Hrs)	08:50	Top of Aquifer (m)	N/A
Pumping Interval (min)	159	Completion Interval Top (m)	254.2
Recovery Interval (min)	2	Completion Interval Bottom (m)	257.2

Reference Point: Top of Casing  
 Reference: M40261.518547 (AT 9)

**Pumping Interval**

	Time (t) Since Pumping Started (minutes)	Depth to Water (metres)		Time (t) Since Pumping Started (minutes)	Depth to Water (metres)
Step 1: 197 lpm	1	7.75	Step 4: 436 lpm	1	31.00
	2	5.94		2	33.69
	3	5.23		3	34.34
	4	5.05		4	34.76
	5	5.05		5	36.70
	6	5.08		6	36.83
	7	5.08		7	37.40
	8	5.10		8	37.60
	9	5.14		9	37.70
	10	5.14		10	37.80
				11	38.00
Step 2: 270 lpm	1	9.00		12	37.97
	2	10.30		13	38.04
	3	10.90		14	38.06
	4	10.95		15	38.05
	5	11.00		16	38.06
	6	11.10		17	38.14
	7	11.10		18	38.16
	8	11.15		19	38.20
	9	11.14		20	38.19
	10	11.17		30	38.34
				65	39.28
Step 3: 380 lpm	1	16.55		73	39.32
	2	17.76	Step 5: 392 lpm	1	38.00
	3	19.41		2	35.13
	4	21.37		3	34.84
	5	23.45		5	34.76
	6	24.30		6	34.75
	7	24.71		7	34.76
	8	24.92		8	34.76
	9	25.06		9	34.79
	10	25.14		10	34.77
	11	25.20		11	34.99
	12	25.28		12	34.82
	13	25.33		13	34.84
	14	25.37		14	34.83
	15	25.41		15	34.81
	16	25.44		16	34.82
	17	25.49		17	34.83
	18	25.33		18	34.83
	19	25.57		19	34.82
	20	25.59		20	34.82
				21	34.83
				22	34.83
				23	34.81
				24	34.81
				25	34.83
				26	34.84
				27	34.84
				28	34.83
				29	34.84
				46	34.88

**Comments:**

Aquifer test conducted by Aqua Tech Supplies & Services Ltd. Water well flowing prior to start of aquifer test but flow rate was not measured. Flow rate was measured at 72 lpm (measuring point was 2" discharge off well head on October 15, 2011. Well shut in and casing pressure build-up to 7psi on October 15, 2011. Casing pressure was 9 psi on October 19, 2011.

